

CLAIMS

What is claimed is:

1. A method for operating a system having a population of designs, each design being adaptable for use in operating the system, the method comprising:

    in response to an input signal, for each design in the population, generating an associated result signal;

    determining a consensus result as a function of at least two of the generated result signals;

    determining an associated fitness level of each design as a function of the associated result signal and the consensus result;

    evolving a new design from at least one design in the population;

    selecting for replacement at least one design as a function of the associated fitness level; and

    replacing the design selected for replacement with the new design.

2. The method of claim 1, further comprising weighting one of the at least two generated result signals for use in determining the consensus result.

3. The method of claim 2, wherein weighting one of the at least two generated result signals includes weighting the result signal as a function of the associated fitness level determined in a prior generation.

4. The method of claim 3, wherein weighting the result signal as a function of the associated fitness level includes weighting the result signal as a function of a

number of generations in which the associated design has been a member of the population.

5. The method of claim 1, wherein determining a consensus result as a function of at least two of the generated result signals includes accumulating result signals from each of the designs over a period of time and determining a consensus result from the accumulated result signals.

6. The method of claim 1, wherein determining a consensus result as a function of at least two of the generated result signals includes determining a statistical result of the at least two of the generated result signals.

7. The method of claim 1, further comprising outputting the consensus result for use in operating the system.

8. The method of claim 1, further comprising selecting at least one of the designs as a function of the consensus result and the associated result signal to generate an output for use in operating the system.

9. The method of claim 1, wherein determining an associated fitness level of each design includes comparing the associated result signal of each design with the consensus result.

10. The method of claim 9, wherein determining an associated fitness level of each design includes determining the associated fitness level as a function of the difference between the associated result signal of the design and the consensus result, relative to the difference between the

associated result signals of the other designs and the consensus result.

11. The method of claim 10, wherein determining the associated fitness level as a function of the difference between the associated result signal of the design and the consensus result comprises determining a bitwise difference between the associated result signal of the design and the consensus result.

12. The method of claim 10, wherein selecting for replacement at least one design comprises selecting a design having the greatest difference between the associated result signal of the design and the consensus result.

13. The method of claim 1, wherein selecting for replacement the at least one design is a function of a relationship between the associated result signal of the at least one design and the consensus result.

14. The method of claim 1, wherein selecting for replacement the at least one design comprises randomly selecting at least one design.

15. The method of claim 14, wherein randomly selecting at least one design comprises biasing a probability of selecting each design as a function of the associated fitness level.

16. The method of claim 1 wherein evaluating the fitness of each design includes weighting the fitness of each design as a function of at least one of: the number of generations in

which the design has been a member of the population, a relationship between the associated result signal of the design and the consensus result, and a probability function.

17. The method of claim 1, prior to generating an associated result signal, further comprising:

evolving a preliminary population of designs by determining an associated fitness level of each design in the preliminary population as a function of fixed evaluation criteria; and

in response to satisfaction of selected completion criteria, ceasing evolving the preliminary population of designs and storing the preliminary population of designs as said population of designs from which the associated result signals are generated.

18. The method of claim 1, wherein each of the steps of the method are performed subsequent to an occurrence of at least one of: reaching a selected time; reaching an end of a predetermined time interval; and a triggering event.

19. The method of claim 18, wherein the triggering event is a failure of the system.

20. The method of claim 1, wherein generating the associated result signal for each design in the population comprises:

programming a programmable device with a first design of the population of designs; and

reprogramming the programmable device with a second design of the population of designs.

21. A method for evolving a population of designs, the method comprising:

in response to an input signal, generating associated result signals for each of a plurality of the designs in the population;

determining a consensus result as a function of the associated result signals;

determining an associated fitness level of each of the population of designs as a function of the associated result signal for each design and the consensus result;

selecting and replacing one of the designs in the population with a new design as a function of the associated fitness level of the selected design.

22. The method of claim 21, wherein determining a consensus result as a function of the associated result signals further includes determining the consensus result as a function of associated fitness characteristics of the plurality of designs.

23. The method of claim 22, wherein determining the consensus result as a function of associated fitness characteristics of the plurality of designs includes assigning weight to each of the associated result signals as a function of the associated fitness characteristics of each design.

24. The method of claim 21, further comprising:

evolving a replacement design using at least two of the designs in the population;

evaluating a fitness of the replacement design as a function of the consensus result;

repeating the steps of evolving and evaluating until the replacement design produces a result signal that is within a selected range of the consensus result; and

wherein selecting and replacing one of the designs in the population with a new design includes replacing one of the designs in the population with the replacement design that produces the result signal that is within the selected range of the consensus result.

25. A fault-tolerant system comprising:

a programmable device programmable with at least one of a plurality of designs, each design being adapted to generate an associated result signal in response to an input signal;

a fitness evaluator configured and arranged to determine a consensus result as a function of associated result signals from at least two of the plurality of designs and to determine an associated fitness level of each design of the plurality as a function of the associated result signals and the consensus result; and

a selector configured and arranged to select and replace one of the plurality of designs with a new design as a function of the associated fitness level of the selected design.

26. The fault-tolerant system of claim 25, further comprising:

an evolution controller configured and arranged to generate the new design from a plurality of the designs.

27. The fault-tolerant system of claim 25, wherein the fitness evaluator is further configured and arranged to

select at least one of the plurality of designs for implementation in an operational device as a function of the associated fitness levels of the plurality of designs.

28. The fault-tolerant system of claim 25, wherein the fitness evaluator is configured and arranged to determine an associated fitness level of a design exhibiting a fault, the associated fitness level being indicative of the fault, and wherein the selector is configured and arranged to select and replace the design exhibiting the fault as a function of said design's associated fitness level.

29. The fault-tolerant system of claim 25, further comprising:

a program controller configured and arranged to sequentially program the programmable device with one design at a time, the input signal being sequentially applied to single designs to generate the associated result signals.

30. The fault-tolerant system of claim 25, wherein the programmable device includes a programmable logic device.

31. The fault-tolerant system of claim 25, wherein the programmable device includes a microprocessor.

32. The fault-tolerant system of claim 25, wherein the programmable device includes at least one of the fitness evaluator and the selector.

33. The fault-tolerant system of claim 25, further comprising a memory for storing at least one of the plurality of designs.